



**[4910-13]**

## **DEPARTMENT OF TRANSPORTATION**

### **Federal Aviation Administration**

#### **14 CFR Part 25**

**[Docket No. FAA-2016-5909; Special Conditions No. 25-626-SC]**

**Special Conditions:** The Boeing Company Model 787-9 Series Airplane; Dynamic Test Requirements for Single-Occupant Oblique (Side-Facing) Seats with Inflatable and 3-Point Restraint Systems

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final special conditions; request for comments.

**SUMMARY:** These special conditions are issued for The Boeing Company (Boeing) Model 787-9 series airplane. This airplane, as modified by Boeing, will have novel or unusual design features when compared to the state of technology envisioned in the airworthiness standards for transport-category airplanes. These design features are single-occupant oblique (side-facing) seats with inflatable and 3-point restraint systems requiring dynamic testing. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for these design features. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** This action is effective on Boeing on **[INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. We must receive your comments by **[INSERT DATE 45 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]**.

**ADDRESSES:** Send comments identified by docket number FAA-2016-5909 using any of the following methods:

- *Federal eRegulations Portal:* Go to <http://www.regulations.gov/> and follow the online instructions for sending your comments electronically.
- *Mail:* Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE., Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- *Hand Delivery or Courier:* Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

*Privacy:* The FAA will post all comments it receives, without change, to <http://www.regulations.gov/>, including any personal information the commenter provides. Using the search function of the docket Web site, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the **Federal Register** published on April 11, 2000 (65 FR 19477-19478), as well as at <http://DocketsInfo.dot.gov/>.

*Docket:* Background documents or comments received may be read at <http://www.regulations.gov/> at any time. Follow the online instructions for accessing the docket or go to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

**FOR FURTHER INFORMATION CONTACT:** Jeff Gardlin, FAA, Airframe and Cabin Safety branch, ANM-115, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington 98057-3356; telephone 425-227-2136; facsimile 425-227-1320.

**SUPPLEMENTARY INFORMATION:**

The FAA has determined that notice of, and opportunity for prior public comment on, these special conditions is impracticable because these procedures would significantly delay issuance of the design approval and thus delivery of the affected airplane.

In addition, the substance of these special conditions has been subject to the public comment process in several prior instances with no substantive comments received. The FAA therefore finds that good cause exists for making these special conditions effective upon publication in the **Federal Register**.

**Comments Invited**

We invite interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data.

We will consider all comments we receive by the closing date for comments. We may change these special conditions based on the comments we receive.

**Background**

On January 29, 2016, Boeing applied for a change to type certificate no. T00021SE to install single-occupant oblique (side-facing) seats with inflatable and 3-point restraint systems in the Model 787-9 airplane.

This airplane is a twin-engine transport-category airplane. It has a 420-passenger capacity and a maximum takeoff weight of 553,000 lbs.

### **Type Certification Basis**

Under the provisions of title 14, Code of Federal Regulations (14 CFR), 21.101, Boeing must show that the Model 787-9 airplane meets the applicable provisions of the regulations listed in type certificate no. T00021SE, or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Model 787-9 airplane because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

In addition to the applicable airworthiness regulations and special conditions, the Model 787-9 airplane must comply with the fuel-vent and exhaust-emission requirements of 14 CFR part 34 and the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

### **Novel or Unusual Design Features**

The Model 787-9 airplane will incorporate the following novel or unusual design features:

Single-occupant oblique (side-facing) seats with inflatable and 3-point restraint systems requiring dynamic testing.

## Discussion

Amendment 25-15 to part 25, dated October 24, 1967, introduced the subject of side-facing seats and a requirement that each occupant in a side-facing seat must be protected from head injury by a safety belt and a cushioned rest that will support the arms, shoulders, head, and spine.

Subsequently, Amendment 25-20, dated April 23, 1969, clarified the definition of side-facing seats to require that each occupant of a seat that is positioned at more than an 18-degree angle to the vertical plane containing the airplane centerline must be protected from head injury by a safety belt and an energy-absorbing rest that supports the arms, shoulders, head, and spine; or by a safety belt and shoulder harness that prevents the head from contacting injurious objects. The FAA concluded that a maximum 18-degree angle would provide an adequate level of safety based on tests that were performed at the time, and thus adopted that standard.

Amendment 25-64, dated June 16, 1988, revised the emergency-landing conditions that must be considered in the design of the airplane. It revised the static-load conditions in 14 CFR 25.561 and added a new § 25.562, requiring dynamic testing for all seats approved for occupancy during takeoff and landing. The intent was to provide an improved level of safety for occupants on transport-category airplanes. Because most seating on transport-category airplanes is forward-facing, the pass/fail criteria developed in Amendment 25-64 focused primarily on forward-facing seats. Therefore, the testing specified in the rule did not provide a complete measure of occupant injury in seats that are not forward-facing; although § 25.785 does require that occupants of all seats that are occupied during taxi, takeoff, and landing not suffer serious injury as a result of the inertia forces specified in §§ 25.561 and 25.562.

To address recent research findings and accommodate commercial demand, the FAA developed a methodology to address all fully side-facing seats (i.e., seats oriented in the airplane with the occupant facing 90-degrees to the direction of airplane travel) and has documented those requirements in a set of proposed new special conditions. The FAA issued policy statement PS-ANM-25-03-R1 on November 12, 2012, titled, “Technical Criteria for Approving Side-Facing Seats,” which conveys the injury criteria to be used in the special conditions. Some of those criteria are applicable to oblique seats but others are not, because the motion of an occupant in an oblique seat is different from the motion of an occupant in a fully side-facing seat during emergency landing conditions.

For shallower installation angles, the FAA has granted equivalent level of safety (ELOS) findings for oblique seat installations on the premise that an occupant’s kinematics in an oblique seat during a forward impact would result in the body aligning with the impact direction. We predicted that the occupant response would be similar to an occupant of a forward-facing seat, and would produce a level of safety equivalent to that of a forward-facing seat. These ELOS findings were subject to many conditions that reflected the injury-evaluation criteria and mitigation strategies available at the time of issuance of the ELOS. However, review of dynamic test results for many of these oblique seat installations raised concerns that the premise was not correct. Potential injury mechanisms exist that are unique to oblique seats and are not mitigated by the ELOS self-alignment approach even if the occupant appears to respond similarly to a forward-facing seat.

The proposed Model 787 airplane oblique business-class seat installations are novel such that the current Model 787 airplane certification basis does not adequately address occupant protection expectations with regard to the occupant’s neck and spine for seat configurations that

are oriented at an angle greater than 18-degrees from the airplane centerline. The FAA has previously issued special conditions no. 25-580-SC for the 787, which reflected the best available criteria at the time. However, as the FAA continues research into the injury mechanisms associated with obliquely oriented seats and the means to measure those injuries, the criteria evolve. These special conditions therefore reflect refinements beyond special conditions no. 25-580-SC, and that incorporate the knowledge gained from research. The intent of the special conditions is unchanged. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Boeing proposes to install on Model 787-9 airplanes 3-point restraint systems and airbag devices as a means to protect each occupant from serious injury in the event of an emergency landing, as required by § 25.562(c)(5). Shoulder harnesses have been widely used on attendant seats, flight-deck seats, business jets, and general-aviation airplanes to reduce occupant head injury in the unlikely event of an emergency landing. A passenger-seat 3-point restraint system is defined as a safety belt (pelvic restraint), a single-belt shoulder harness, and the seat structure associated with the harness attachment points. The 3-point restraint system is intended to protect the occupant from serious injury, and the means of protection must take into consideration a range of occupant stature, ranging from a 2-year old child to a 95th percentile male, in addition to the oblique seat orientation. The use of 3-point restraint systems on transport-category airplane passenger seats is rare; however, existing regulations provide an adequate safety standard for these installations. The FAA has issued advisory material on acceptable means of compliance for combined shoulder-harness and safety-belt restraint systems, such as the 3-point restraint system.

Inflatable airbag devices are designed to limit occupant forward excursion in the event of an accident. This will reduce the potential for head injury, thereby reducing the head injury criteria (HIC) measurement. While inflatable airbags are now standard in the automotive industry, the use of an inflatable airbag device is novel for commercial aviation. Special conditions exist for airbags installed on seat belts, known as inflatable lapbelts, which have been installed on Boeing passenger seats. The FAA has also issued special conditions for structure-mounted airbags on the Model 787-9 that are similar to those for inflatable lapbelts, but that account for the differences between the two types of airbag installations.

### **Applicability**

These special conditions are applicable to the following Boeing Model 787-9 airplanes: AAL ZB 446 (Project PS15-0762), AMX ZB 676 (Project PS15-0588), XIA ZB 812 (Project PS16-0060), and JAL ZB 424 (Project PS15-0723).

### **Conclusion**

This action affects only certain novel or unusual design features on one model of airplanes. It is not a rule of general applicability.

The substance of these special conditions has been subject to the public-comment process in several prior instances with no substantive comments received. Therefore, because a delay would significantly affect the certification of the airplane, the FAA has determined that prior public notice and comment are unnecessary and impracticable, and good cause exists for adopting these special conditions upon publication in the **Federal Register**. The FAA is requesting comments to allow interested persons to submit views that may not have been submitted in response to the prior opportunities for comment described above.



## **List of Subjects in 14 CFR Part 25**

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

### **The Special Conditions**

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Boeing Model 787-9 airplanes.

In addition to the requirements of §25.562:

#### **1. Head-Injury Criteria**

Compliance with § 25.562(c)(5) is required, except that, if the anthropomorphic test device (ATD) has no apparent contact with the seat/structure but has contact with an airbag, a HIC unlimited score in excess of 1000 is acceptable, provided the HIC15 score (calculated in accordance with 49 CFR 571.208) for that contact is less than 700.

#### **2. Body-to-Wall/Furnishing Contact**

If a seat is installed aft of structure (e.g. interior wall or furnishings) that does not provide a homogenous contact surface for the expected range of occupants and yaw angles, then additional analysis and/or tests may be required to demonstrate that the injury criteria are met for the area which an occupant could contact. For example, if an airbag device is present, different yaw angles could result in different airbag-device performance, and additional analysis or separate tests may be necessary to evaluate performance.

### 3. Neck Injury Criteria

The seating system must protect the occupant from experiencing serious neck injury. If an airbag device is present, the assessment of neck injury must be conducted with the airbag device activated, unless there is reason to also consider that the neck-injury potential would be higher for impacts below the airbag-device deployment threshold.

- a. The  $N_{ij}$  (calculated in accordance with 49 CFR 571.208) must be below 1.0,

where  $N_{ij} = F_z/F_{zc} + M_y/M_{yc}$ , and  $N_{ij}$  critical values are:

- i.  $F_{zc} = 1530$  lb for tension
  - ii.  $F_{zc} = 1385$  lb for compression
  - iii.  $M_{yc} = 229$  lb-ft in flexion
  - iv.  $M_{yc} = 100$  lb-ft in extension
- b. In addition, peak upper-neck  $F_z$  must be below 937 lb of tension and 899 lb of compression.
  - c. Rotation of the head about its vertical axis, relative to the torso, is limited to 105 degrees in either direction from forward-facing.
  - d. The neck must not impact any surface that would produce concentrated loading on the neck.

### 4. Spine and Torso Injury Criteria

- a. The lumbar spine tension ( $F_z$ ) cannot exceed 1200 lb.
- b. Significant concentrated loading on the occupant's spine, in the area between the pelvis and shoulders during impact, including rebound, is not acceptable. During this type of contact, the interval for any rearward (X direction) acceleration exceeding 20g must be less than 3 milliseconds as measured by the thoracic

instrumentation specified in 49 CFR part 572, subpart E, filtered in accordance with SAE International (SAE) J211-1.

- c. The occupant must not interact with the armrest or other seat components in any manner significantly different than would be expected for a forward-facing seat installation.

## **5. Pelvis Criteria**

Any part of the load-bearing portion of the bottom of the ATD pelvis must not translate beyond the edges of the seat bottom seat-cushion supporting structure.

## **6. Femur Criteria**

Axial rotation of the upper leg (about the z-axis of the femur per SAE Recommended Practice J211-1) must be limited to 35 degrees from the nominal seated position. Evaluation during rebound does not need to be considered.

## **7. ATD and Test Conditions**

Longitudinal tests conducted to measure the injury criteria above must be performed with the FAA Hybrid III ATD, as described in SAE 1999-01-1609. The tests must be conducted with an undeformed floor, at the most-critical yaw cases for injury, and with all lateral structural supports (e.g., armrests or walls) installed.

### ***Structure-Mounted Airbag and Inflatable Lapbelt Special Conditions***

When present, the structure-mounted airbag device must meet special conditions no. 25-605-SC, “Boeing Model 787-9 Airplane; Structure-Mounted Airbags.” When present, the inflatable lapbelt(s) must meet special conditions no. 25-431-SC, “Boeing Model 787 Series Airplanes; Seats with Inflatable Lapbelts.”

**Note:** As indicated in the special conditions above, airbags and inflatable lapbelts must be shown to not affect emergency-egress capabilities in the main aisle, cross-aisle, and passageway.

Issued in Renton, Washington, on July 27, 2016.

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[FR Doc. 2016-18449 Filed: 8/2/2016 8:45 am; Publication Date: 8/3/2016]